Progress on the low-background cosmogenic ^{14}C extraction line at Dalhousie University, Halifax, Nova Scotia, Canada

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Applications of cosmogenic ^{14}C produced in minerals or ice on Earth are providing a new frontier in exposure dating and landscape erosion rate studies. However, technological challenges have limited the applications of the method, owing to the relatively high abundance of ^{14}C in the atmosphere and the ~0.04% abundance of CO_2 in lab air.

A new stainless steel UHV ^{14}C extraction line was assembled in 2014 and initial cleaning and final leaks were resolved by January 2017. It is one of only six cosmogenic ^{14}C extraction lines in the world and only the second to be developed using stainless steel in lieu of glass components. The predicted benefit of using stainless steel is in providing a better vacuum and lower and more uniform background, an important consideration as only ~10^6 atoms of ^{14}C are expected to be collected from a 5 g sample of quartz. After removal of meteoric CO_2 from the boat, flux, and quartz at low temperature (500ºC), ultrapure O_2 is flowed over the melting quartz aliquot (~5.000 g) at 1300ºC to convert the in situ produced ^{14}C to $^{14}CO_2$. The $^{14}CO_2$ is then purified, using temperature-specific Liquid Nitrogen-slush traps to remove SO_x, NO_x, and other condensable gases, and a high temperature Ag-Cu mesh oxidation. Additionally, low-level CO_2 –samples can be spiked with ^{14}C-dead well gas. Once collected, the purified CO_2 will be analyzed for $^{14}C/^{12}C$ against standards on the MICADAS gas-source accelerator at ETH Zurich or the future gas-source A.E. Lalonde AMS lab at uOttawa, eliminating a need to graphitize the CO_2.

Preliminary volumetric measurements indicate that a plateau at <4 nmol CO_2 can be achieved as the nominal line background within 6 days after the line is open (e.g. sample exchange). It is hoped this time can be reduced in order to measure more samples in a year, but considering it is low, it may not be necessary, depending on the $^{14}C/^{12}C$ of the residual CO_2. Assuming that most of this carbon is ^{12}C from degassing of the steel and other line parts, the background yields $8 \lozenge 10^{14}$ atoms ^{12}C, yielding a $^{14}C/^{12}C$ of 7×10^{-9} , i.e., that the number of ^{12}C atoms is three orders of magnitude lower than what will be expected when CO_2 is extracted from the quartz. Testing with CRONUS international interlaboratory samples is planned for February 2017.

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